The inside story. . . .

HD 11

RL01
SOFTWARE-COMPATIBLE
DISK AND
TAPE CONTROLLER
BY CRDS

EASY CABLE
ACCESS TO
PDP-11 OR
LSI-11 INTERFACE

ECC DATA
PROTECT

DEI CARTRIDGE
TAPE DRIVE

4-VOLTAGE
POWER SUPPLY
(REMOVED FOR CLARITY)

21 MEGABYTE
SHUGART SA4000
WINCHESTER
DRIVE

HD-11

The HD-11 is a 21 megabyte (formatted) fixed disk system that utilizes Winchester technology to achieve high storage capacities at a low cost. The use of fixed disk technology provides a lower cost-per-byte of storage and unlike removable media disk drives requires no preventive maintenance.

. . . of our DEC-11 Winchester disk system with fail-safe cartridge tape back-up.

However, data loss is total should the sealed disk ever be unrecoverable. To provide back-up or archival storage a 3M cartridge drive is available as an option and conveniently mounts in the HD-11 chassis utilizing the same power supplies and controller/interface as the disk drive.

This unique packaging of a disk and tape drive in the same chassis — sharing common electronics — is a revolutionary concept in the minicomputer field. Combining the new fast and inexpensive non-removable disk technology with another new technology, the 3M cartridge, provides a method of failsafing disk drives or allowing large off-line storage (tape libraries) to be created. Error connection (ECC) has been implemented on both the tape and disk peripherals for further reliability.

The HD-11 is completely software compatible with the RL01, allowing immediate and easy use of the product. No handlers need to be integrated into your operating system, and the HD-11 executes DEC's RL01 disk diagnostics.

A timing track exists on an unused section of the disk and is read with a separate fixed head. This timing tracks makes the acquisition of data easier and allows extremely accurate disk sectoring.

Unlike removable media drives, the SA4000 requires no cumbersome air filtration system. The media is sealed inside a clear plastic bubble and may only be removed or replaced in a clean room. A small filter exists that allows equalization of the air pressure inside the plastic bubble if altitude changes. Through the use of fixed media, problems of dust and dirt contamination are eliminated.

The SA4000 represents superior technology by a company that has clearly proven itself by its domination of the floppy disk market. This Winchester disk has already seen its first year of production and is in use by several leading OEM customers.
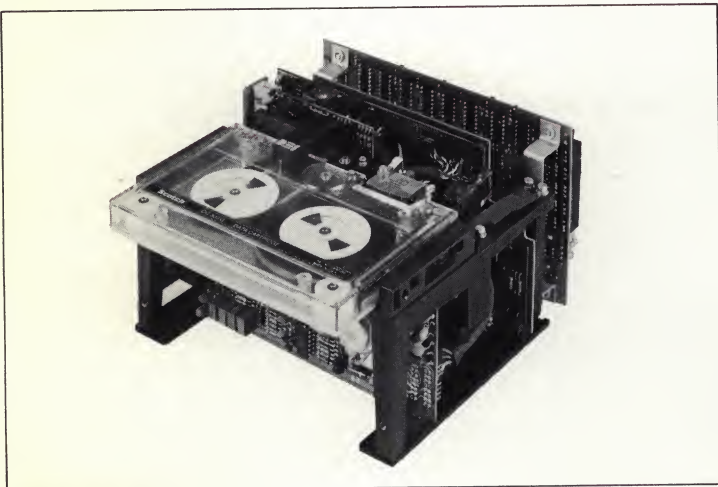
Tape Drive

over. A 32 bit CRC is used for error detection in these operations.

These procedures in almost all cases ensure data reliability, but for additional security, CRDS has added ECC to the system. In order to protect data if a small section of tape is damaged after writing, ECC has been implemented at the handler level. This ECC procedure allows for the reconstruction of an entire block of data as long as no more than 1 block in every 50 is defective. In fact, it is possible to splice out a one inch section of tape anywhere along the tape without losing data.

HD-11 CONTROLLER

The HD-11 controller consists of the HC-300 controller card plus an interface card (either Q-bus or Unibus).

(1) *The RL01 interface for the LSI-11 requires 2 quad slots and a special backplane (used in the 11/03 L) to make the connection between them. Not only does this limit the choice of backplanes, but these backplanes do not take advantage of compact dual-height cards.* This is especially important if users are to leave room to upgrade to an LSI-11/23. The diagram below shows the difference between a DEC 11/03L with an RL01 disk and a CRDS MF-211 with a HD-11 disk.

11/03L and RL01			
	A B	C	D
1	11/23	WASTED	
2	DLV-11J	WASTED	
3	32K MEM	WASTED	
4	32K MEM	WASTED	
5	32K MEM	WASTED	
6	32K MEM	WASTED	
7	RLV-11 →		
8	RLV-11 →		
9	BDV11-A →		

CD slots are wired to connect adjacent modules and cannot be used as slots for dual-height Q-Bus peripherals.

0 DUAL-HEIGHT SLOTS AVAILABLE.

MF-211 and HD-11			
	A B	C	D
1	11/23	DLV-11J	
2	32K MEM	32K MEM	
3	32K MEM	32K MEM	
4	HC-200 →		
5			
6			
7			
8			

Bootstrap built into HC-200.

NOTE: The HD-11 interface card can be used in either the 1103L backplane or the MF-211.

8 DUAL-HEIGHT SLOTS AVAILABLE.

(2) The HD-11 controller contains a 256 word bootstrap that resides in ROM from locations 773000 through 773776. It allows booting of any of the 4 units and may be disabled if use of another bootstrap is preferred.

(3) The HD-11 controller utilizes DMA burst mode for 4 cycles. Unlike the RL01, the overhead of requesting a DMA bus mastership is amortized over 4 memory reads or writes. CRDS did not utilize DEC's standard LSI DMA sequencers but instead put in its own microcoded sequencer to utilize the bus as efficiently as possible.

(4) A 50 conductor ribbon cable connects the interface card to the controller card which·is located inside the HD-11 chassis. Data along this bus is sent in parallel. Unlike the RL01, most controller functions are in the drive, not in the backplane. Less power is drawn from the host CPU, and fewer card slots are required.

(5) The device address and vector interrupt address may easily be changed via the use of jumpers.

Controller Card (HC-300)

Located within the drive chassis, it provides for complete emulation of the RL01 and controls the reading and writing of data to and from the disk.

The card contains a 2901 high speed microprocessor that fetches and executes instructions in 167 nanoseconds. However, even at this high rate, it is still necessary to use MSI and SSI logic to handle the data path. This is both a conservative approach and was done in order to handle the fast stream of data without placing any more burden on the bandwidth of the Q-Bus than was absolutely necessary.

This controller card is a general purpose Winchester Disk drive/cartridge tape drive controller. It is ideal for OEM users who wish to interface to processors other than an LSI-11 or PDP-11 computer. Some of its most important features include:

(1) *ECC*—Error correction codes have been added to the end of each sector to allow for restoration of short sequences of bad bits. Because a CRC check is necessary to determine if an error did occur, the addition of ECC circuitry adds no cost and provides an extra margin of reliability and data security.

(2) *DUAL SECTOR BUFFERS* The controller contains 2 complete 256 byte data buffers alternately used for data transfer with the disk and DMA channel.

(3) *TRACK RELOCATION* The manufacturer of the disk drives tests all disks for media problem spots. Before delivery of the HD-11 disk drives, the locations of these bad spots are stored on an unused track of the disk itself. On initialization, this track is read and information used to automatically remap all accesses to the disk.

Every controller has the ability to drive the 3M cartridge tape drives whether or not this option is purchased. CRDS has been able to utilize the same controller for both peripheral drives, thereby lowering costs.

HD-11 SPECIFICATIONS

Data Organization

	Physical Drive	Logical Drive (RL01 Subunit)
bytes per sectors	256	256
sectors per track	60	40
tracks per head	202	256
heads per drive	8	2
bytes per track	15,360	10,240
bytes per cylinder	122,880	20,480
bytes per drive	20,971,520	5,242,880

Recording Technique

Method:	MFM
Bit Density	5534 BPI
Track Density	172 TPI

Performance

Typical peak burst DMA transfer rate	1.3 μs per word
Typical sector data transfer rate	2.3 μs per word
Typical logical track transfer rate	5.2 μs per word

	Over 4 RL01's	Over 1 RL01
Track to track access	20	20
average seek time	60	32
max seek time	125	49
rotational speed	2964 RPM	
start time	90 sec.	

Operating Environment

Temperature	50°F to 105°F
Relative humidity	8 to 80%
Altitude	6,000 Ft.

Power

HC-200: +5 VCD ±5% at 2 Amps
HD-11: 110 VAC, 50/60 HZ at 4 Amps, single phase
230 VAC, 50/60 HZ at 2 Amps, single phase

Mechanical

Size: 10.5 inches high, 19 inches wide, 24 inches deep
Weight: Approximately 100 lbs.
Mounting: Standard RETMA 19 inch rack mount on slides (provided)
Cables: Standard length of 10 feet between interface card and HD-11 chassis.
Other optional lengths available.

THE HD-11 DISK DRIVE

Disk Drive

CRDS selected Shugart Associates' SA4000 as its source for Winchester drives. This drive has been in production for over one year. It is a relatively simple and straight-forward 14 inch drive that does not strain the limits of either Winchester technology or the availability of media and other components.

A band-driven head-actuation assembly provides substantial reliability at a low cost. Compared to voice coils with servos and/or track following logic, this approach is simpler and less costly.
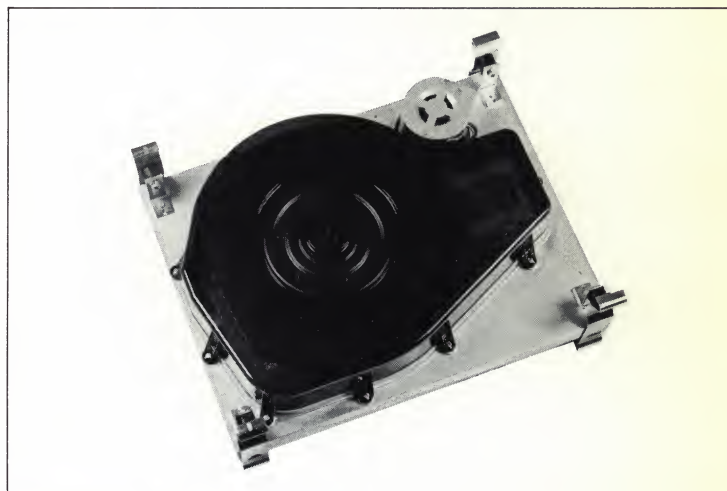
Disk Drive

THE HD-11 TAPE DRIVE

Tape Drive

The 3M-tape cartridge featured in the HD-11 is manufactured by Data Electronics, Inc. and has been in production for over 2 years. It has extensive field experience in small business systems environments.

The removable tape cartridge is a convenient size, is easily stored, and has a formatted data capacity of 15.7 megabytes or the equivalent of 3 RL01 disk packs. This tape drive is not software-compatible with any DEC peripheral.

We suggest that the device be used to back-up an entire RL01 disk equivalent, and to restore this tape back onto the disk at a later time. Either operation can be performed in less than 6 minutes, and it is not necessary to introduce a new handler to the operating system. A completely independent program is provided to the user allowing failsafing or restoration of from 1 to 3 5-megabyte RL01 sections, in a maximum of only 6 minutes per RL01 section.

Data Integrity Features

In order to ensure the reliability of data recorded on tape, it was necessary to build certain functions into the tape drive.
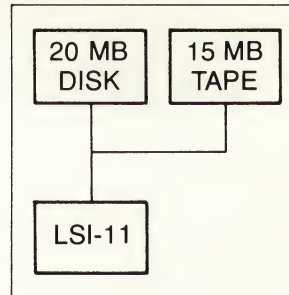
Because the tape drive can be exposed to contamination, all data is read while writing is still in progress. Because of separate read and write heads and separate data paths in the controller and drive electronics, data is immediately verified. If data is not written correctly, it is rewritten and if necessary a section of the tape is passed
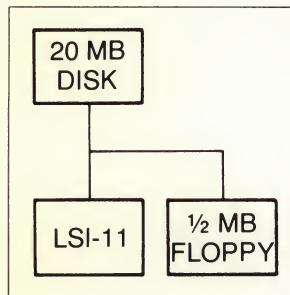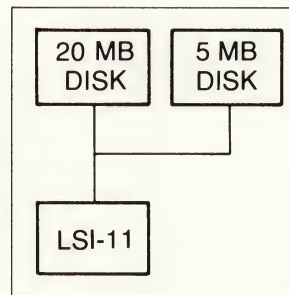
HD-11 CONFIGURATIONS
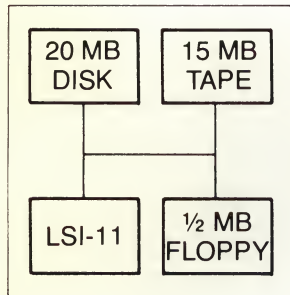
1. MF-211 w/one or two floppy drive (s)
HD-11 w/tape
This system provides tape for back-up of large amounts of data plus a floppy disk drive to load diagnostics or for interchange with DEC, IBM, and others.

```
┌──────────┐  ┌──────────┐
│ 20 MB    │  │ 15 MB    │
│ DISK     │  │ TAPE     │
└────┬─────┘  └────┬─────┘
     │             │
┌────┴─────┐  ┌────┴─────┐
│ LSI-11   │  │ ½ MB     │
│          │  │ FLOPPY   │
└──────────┘  └──────────┘
```

2. MF-211 w/one floppy disk drive
HD-11 without tape
This system utilizes the floppy disk for both interchange and back-up. Though it can back-up only 1/40th of the HD-11 disk this may be acceptable if the user only backs up source files or those files changed that day.

```
┌──────────┐
│ 20 MB    │
│ DISK     │
└────┬─────┘
     │
┌────┴─────┐  ┌──────────┐
│ LSI-11   │  │ ½ MB     │
│          │  │ FLOPPY   │
└──────────┘  └──────────┘
```

3. MF-211 without floppy disks
HD-11 with tape
This system allows interchange only between other systems and an HD-11. If no other systems are available, to initialize, the user must plug a floppy disk or RL01 into his system, or make use of CRDS's RL01-to-tape conversion service. However, once started, this system in many environments needs no floppy.

```
┌──────────┐  ┌──────────┐
│ 20 MB    │  │ 15 MB    │
│ DISK     │  │ TAPE     │
└────┬─────┘  └────┬─────┘
     │             │
┌────┴─────┐
│ LSI-11   │
│          │
└──────────┘
```

4. 11/03 L
RL01
HD-11 with or without tape
The user needs access to the RL01 on a continued basis for interchange to other systems with RL01's. The RL01 may also be used for back-up. The MF-211 *cannot* be used. Its back-plane is incompatible with the RL01. The HD-11 can supply a large work-space for this user and is certainly less expensive than 4 RL01's.

```
┌──────────┐  ┌──────────┐
│ 20 MB    │  │ 5 MB     │
│ DISK     │  │ DISK     │
└────┬─────┘  └────┬─────┘
     │             │
┌────┴─────┐
│ LSI-11   │
│          │
└──────────┘
```

A FAIL-SAFE SOLUTION TO DATA LOSS BECAUSE OF AN UNRECOVERABLE DISK:

The HD-11 allows several solutions to the problem of providing back-up copies of programs or other data:

(1) Our optional 3M cartridge drive provides 15.72 megabytes of storage, enough to back-up 3 of the 4 "pseudo-RL01 packs" that the HD-11 contains. This is essential for large data bases that change frequently.

(2) Our single drive double-density FD-211 floppy disk systems provides a 1/2 megabyte of removable storage. For program development applications requiring only source file back-up, this is an excellent alternative.

(3) As a temporary measure, it is reasonable to back-up files on one of the 4 RL01 sections of the HD-11 and write-protect that disk segment. This provides redundancy as well as a quicker back-up than the use of tape or floppy disk. However, if the drive were to need repair, the user would lose his data.

(4) If the user is inextricably attached to cartridge disk drives, he might purchase both one RL01 drive and an HD-11. This saves the cost of a second RL01 and its associated maintenance, and gains a large convenient work-space of 21 megabytes. The number of time-consuming disk pack swaps most cartridge disk users continually experience is then reduced dramatically.

AN EFFECTIVE SOLUTION TO THE PROBLEM OF INTERCHANGE BETWEEN SYSTEMS AND THE ABILITY TO READ SOFTWARE DISTRIBUTION MATERIAL

Most systems require at some time the ability to read standard format media. For users with several systems, however, this need not be built into every system. These users may make use of any of the following alternatives:

(1) Have a standard media peripheral such as a CRDS FD-211 or RL01 drive on standby to be plugged into a particular system when needed.

(2) Have one system permanently attached to a CRDS FD-211 or RL01 and use the HD-11's optional cartridge tape drive to transfer between that and other systems.

(3) Communicate between systems with serial data links. For single system users, we suggest:

A. The low cost of the FD-211 allows for a very favorable price comparison of the HD-11 plus a FD-211 with 2 RL01's.

B. CRDS will provide a service to its users that will take RL01 distribution media from DEC and place it on a tape cartridge so it may be read by the HD-11.

Charles River Data Systems, Inc.

CRDS